Mixed Signal Power Manager Tutorial

Microsemi

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Introduction

The purpose of this document is to provide clear step-by-step instructions to take you through the first usage of the MPM GUI and design examples. The tutorial illustrates the usage of power sequencing and timing slots, voltage threshold setting, and trimming options. Throughout the tutorial are questions to test your understanding of the steps taken and test your understanding of the various concepts. Answers are provided in Appendix A – "Answers" on page 15.

Requirements for this Tutorial

1. A2F-EVAL-KIT: SmartFusion Evaluation Kit
   www.actel.com/documents/A2F_EVAL_KIT_QS.pdf
2. MPM-DC-KIT: Mixed-Signal Power Management Daughter Card
   www.actel.com/products/hardware/devkits_boards/mpm_dc.aspx
3. MPM for SmartFusion GUI and Design Files Installer
   www.actel.com/download/rsc/?f=SmartFusion_MPM_DF
4. Installed version of FlashPro Software, either as part of a full Libero® Integrated Design Environment install (automatic) or standalone FlashPro installation from
   www.actel.com/download/program_debug/flashpro/default.aspx
5. USB to UART driver for eval kit, if not already installed
   www.actel.com/documents/CP2102_driver.zip

Additional Resources Online

Mixed Signal Power Manager for SmartFusion User's Guide
www.actel.com/documents/SmartFusion_MPM_UG.pdf

Mixed Signal Power Manager (MPM) for SmartFusion Reference Design Product Brief
www.actel.com/documents/MPM_SmartFusion_PB.pdf

Setting Up the Software

1. Install the MPM GUI from the installer www.actel.com/download/rsc/?f=SmartFusion_MPM_DF
2. Unzip the installer from the zip file and then run the installer. Use the default settings and install to *C:\Actel\SF_MPM_RefDesign_v3.0*. While the install is running you can setup the hardware.
3. If you do not already have a full Libero IDE installation on your machine, install the FlashPro software from www.actel.com/download/program_debug/flashpro/default.aspx.
4. Install www.actel.com/documents/CP2102_driver.zip

Setting Up the Hardware

1. Unpack the A2F-EVAL-Kit and the MPM-DC-KIT. You should now have the following:

   1 A2F-EVAL-KIT board

   1 MPM-DC-KIT board

   2 USB cables

   1 9 V power supply
2. On the blue eval kit, there are two jumpers on the right side of the board. The top one, JP7, should be set to the USB Prog setting so you can program the device through the USB header. The bottom one, JP10, should be set to the FPGA position, as shown in Figure 1 on page 4. There are two other jumpers on the board, which usually do not need changed: J6 (near the RJ45

jack) should have a jumper connected and JP6 (right side of SmartFusion device) should be set to EXT 1.5 V.

On the MPM Daughter Card there are 8 jumpers. The top four—JP17, 18, 19, and 20—should be set to the Trim position (right). The bottom four—JP12, 13, 14, and 15—should all have jumpers connected.

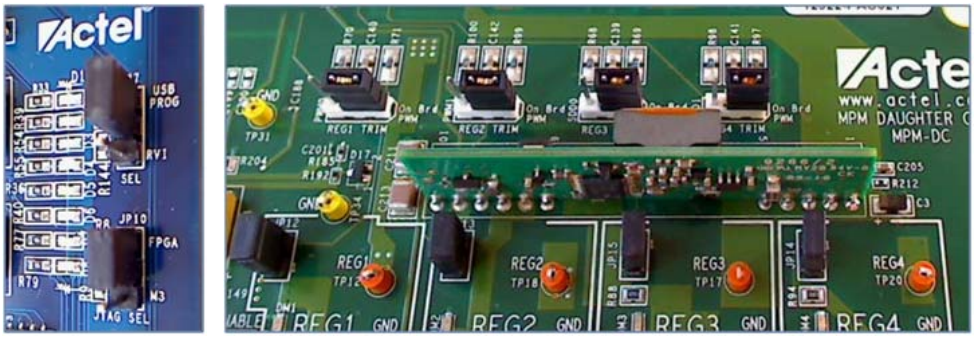

***Figure 1* • Jumper Settings**

3. Connect the two boards together with the mixed signal header, making sure the headers are correctly aligned for pin 1. The boards are different heights, so put something non-conductive under the eval kit if you can. The spare international adapters from the power supply work well.
4. Connect the 2 USB cables from your computer to the USB connections on the eval kit.
5. Check that the power supply on the MPM-DC-KIT is in the off (down) position. Connect the 9 V power supply to the wall power supply and then to the MPM-DC-KIT. **DO NOT TURN IT ON YET**. You must program the SmartFusion device first since, since you do not know what was last programmed into the board.

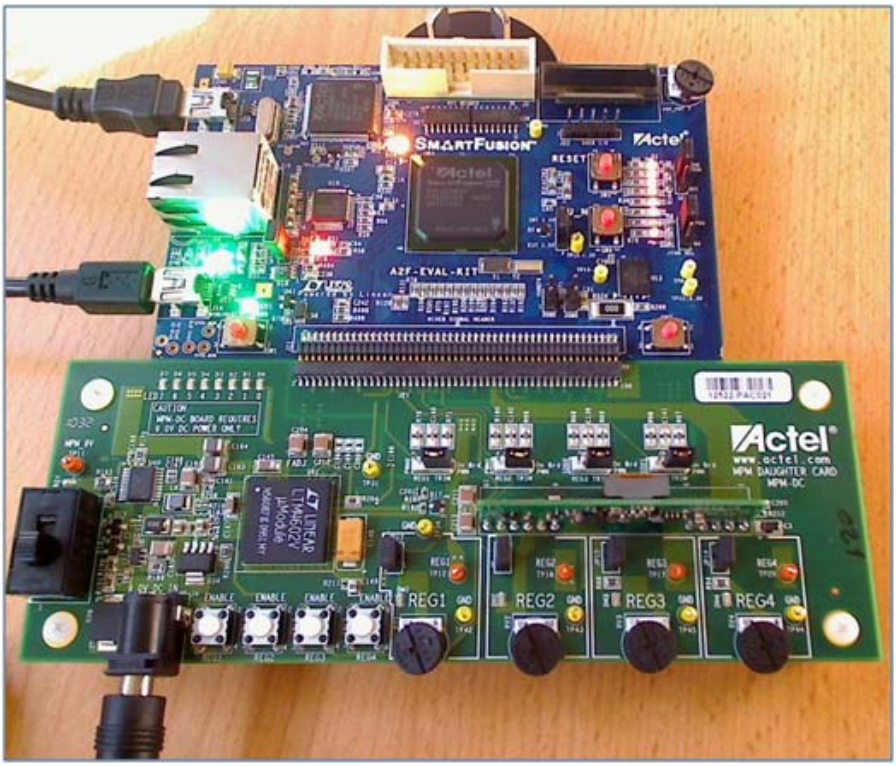

***Figure 2* • Fully Connected Hardware Setup**

1 – Programming

Programming the SmartFusion Device for the First Time

When using the MPM GUI to reconfigure power sequencing, you need only write to the eNVM registers of the device. But the first time you set up the device for use with the MPM Daughter Card, you need to program the SmartFusion device to contain the MPM design, since you may not know what was programmed to the device the last time it was used.

1. From the desktop, click the SmartFusion MPM GUI icon or launch from the **Start** menu (Figure 1-1. It may have already auto launched if you just completed the install.

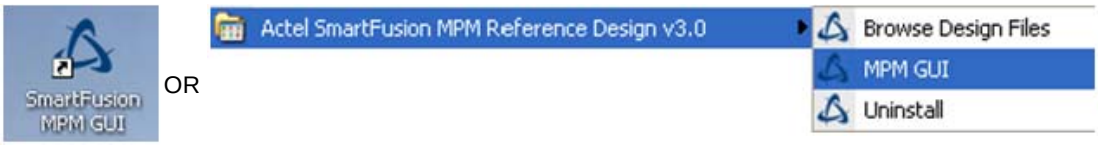

***Figure 1-1* • Launching the MPM GUI**

2. In case you have used this before, select the default design from the File menu. This should be shown as C:\Actel\SF_MPM_RefDesign_v3.0\bin\SF_MPM_Reference_Design.txt in the recently accessed files list. Or select **Files** > **Load Values** and navigate to the file.
3. From the File menu, select **Write NVM and Fabric**. This tells the software to write both the NVM values and the design into the FPGA fabric. It will also program the appropriate firmware for the ARM®Cortex™-M3 processor to use.
4. If you are doing this for the first time, you will be asked to locate the FlashPro executable. This is either in your Libero install directory or in the FlashPro install if you installed it standalone. Most likely it will be in your Actel/Libero_v9.0/Designer/bin folder. Look for **FlashPro.exe**.
5. Once you locate the executable, it will launch a CMD window and begin to program the device. Basically you are running the FlashPro software in scripted mode. If programming succeeds, the result will be similar to Figure 1-2. The window does not close automatically, so that you can view any of the messages shown. You can close the window clicking the X in the upper right corner.

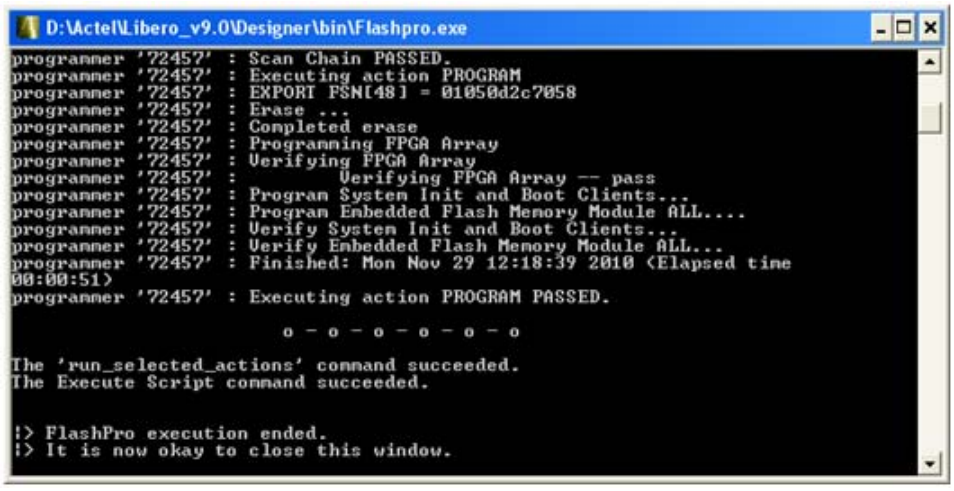

***Figure 1-2* • Successful Programming of the SmartFusion Device**

Power-Up and Power-Down Sequencing

Now that you have the correct design programmed to the SmartFusion device, you can proceed with running the demo.

1. Press **Reset** on the eval Kit to reset the device and start the MPM design.
2. Power up the MPM Daughter Card.

   As indicated on the OLED display, SW 1 will initiate a power-up or power-down sequence, depending on the current state. SW 2 will scroll through the OLED display. Try out these functions one at a time.
3. Rotate all four regulator POTs to the far left (counter clockwise) position.
4. Press **SW1** on the eval kit. All four regulator LEDs should come on, one after the other.
5. Press **SW1** to initiate a power-down sequence.
6. Rotate all four regulator POTs to the far right (clockwise) position.
7. Press **SW1**. The LED for REG1 will come on, showing that the power supply is enabled. But the sequence does not continue. Rotate the POT for REG1 all the way to the left (counterclockwise). You should see the REG2 light come on. Repeat until all POTs are set all the way counterclockwise and all LEDs stay on.

Note: If a regulator in the sequence does not reach nominal voltage, the next SLOT does not start. So if REG1 does not reach nominal, REG2 is never enabled, so it stops the sequence. This will be important to think about later in the tutorial. If the sequence fails to complete, you can choose whether to retry or restart the sequence.

8. In the GUI, examine the MISC tab. At the top of this section you will see the Power on Sequence Settings. The default setting should be Restart Sequence. If this is not showing, set it.
9. Change the Slot Timeout value to 5000 ms. You will also notice when you click on the section that the online help on the left updates to show information on the current function.
10. Select **File** > **Write NVM** to update the value in the device. You do not need to reset or reboot the device for these changes to take effect. Programming is much faster this time since you are program the eNVM values only. Close the programming window when it displays PROGRAM_NVM_ACTIVE_ARRAY PASSED.
11. On the board, rotate POT3 and 4 to the far right again to initiate a failure condition.
12. Press **SW1** to power down if currently active; then press **SW1** to initiate the power-up sequence. You will see that the LEDs for 1, 2, and 3 come on but REG4 LED does not.

    On the "Answer Sheet " on page 12, answer the following question, and each of the remaining nine questions throughout the text:

Q1. What do you have to do to get all four LEDs on and complete the sequence?

One more thing you can change very easily on the power-up and power-down is the power-down sequence.

13. In the MPM GUI, Graph tab, view the visual representation of the power-up and power-down sequence. You should see that the power-up sequence is Rail A1 first and the power-down is Rail A1 last. The horizontal access represents time.
14. On the Misc tab, find the power-off sequence section. Change the power-off sequence so that REG1 shuts down first. Check on the graph if your setting has achieved the desired result.
15. Once you have the sequence showing correctly on the graph, use **Write NVM** to program to the device.
16. Rotate all the POTs to the far left and use SW1 to demonstrate your new sequence.

Understanding Slots

Go back to the MPM GUI and select the **Power** tab. With Rail A1 selected on the left, you should see in the power sequencing section that Rail 1 is assigned to Slot 1. Step through the first 4 rails and view which rail is assigned to which slot. The voltage thresholds will be covered in the "Voltage Thresholds " section on page 8.

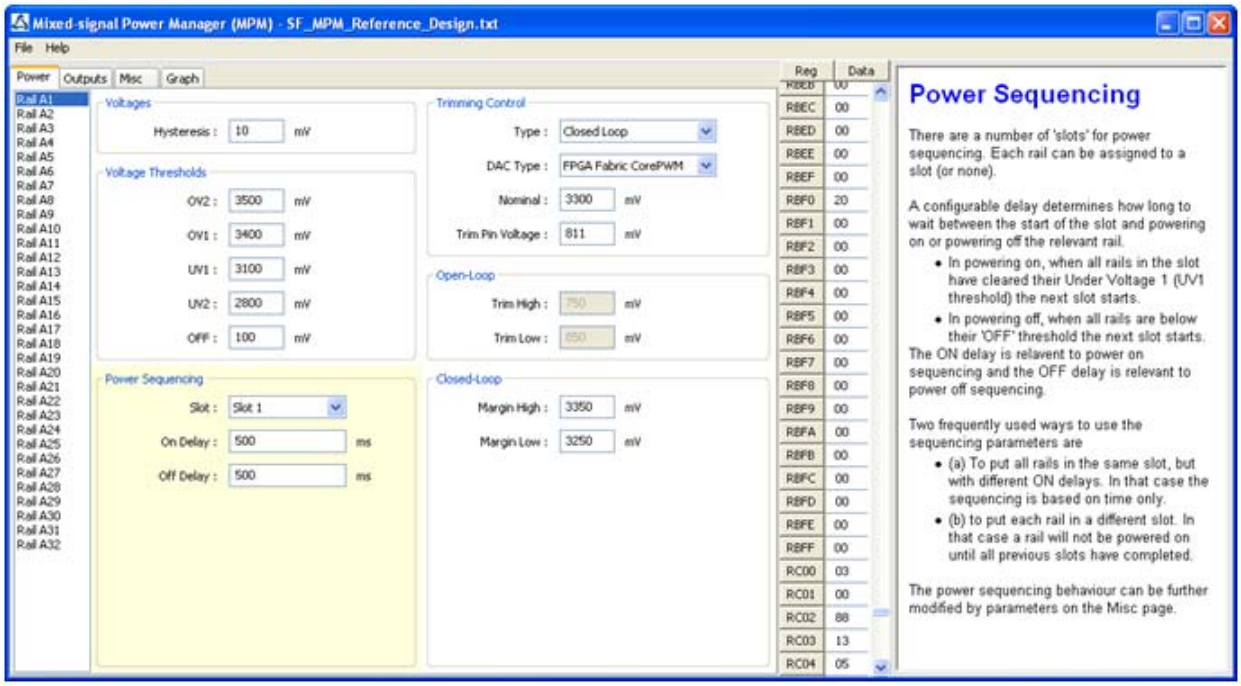

***Figure 1-3* • Power Tab in the MPM GUI**

1. Change rail A2 and A3 to be in the same slot.

Q2. If Rail A2 fails to reach nominal, what happens to Rail A3?

2. Test your theory on hardware (Write NVM, use the POT to make Rail2 fail, and use SW1 to start the sequence).

Q3. What Happens to Rail A4 and why?

Voltage Thresholds

This section focuses on Rail A1 as an example. .

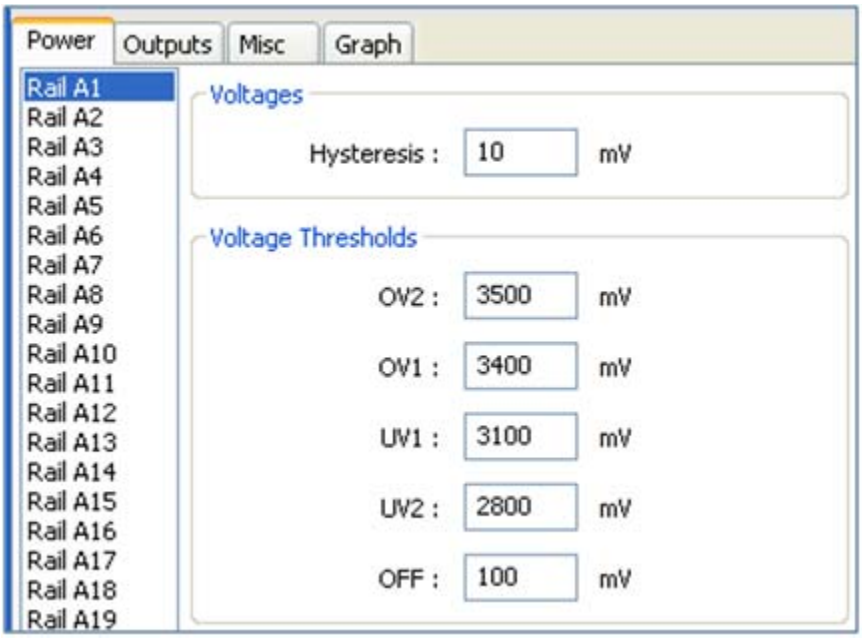

***Figure 1-4* • Voltage Thresholds for Rail A1**

1. Set all the POTs to the far left for this section, so that the power rails power on successfully and stay on.
2. On the OLED display, you should see the display shown in Figure 1-5.

***Figure 1-5* • Display SW1 and SW2**

If you do not, then reset the device to get it to restart from the beginning.

3. Press **SW2**. The OLED displays the version information.
4. Press **SW2** again. The status is shown as Stopping, Stopped, Starting or Started. Press **SW1** and cycle through until status shows Started.

5. Press **SW2** again to view the values for channel 1 (Figure 1-6). The naming is somewhat inconsistent, but Channel 1 on the OLED represents Rail A1 in the GUI, which relates to REG1 on the MPM board.

***Figure 1-6* • Display Channel 1**

6. Remove JP12 from the board (put it in a location where you can easily find it later). Rotate the POT for REG1 to view each of the positions UV1, UV2, NOM, OV1, and OV2.

Q4. What would you have to do to get the position on the far left of the OLED to activate?

7. Press **SW2** to change the OLED to show the second channel.
8. Rotate the POT for REG2.

Q5. What would you have to do to get OV1 to display? Test your theory in hardware.

Hint: You do not have to reprogram the part.

Controlling Output Logic

Go back to the MPM GUI and select the **Outputs** Tab. The LEDs on the top left of the MPM Daughter Card are used to indicate the values of outputs 1-8. LED0, for example, is Output1.

1. For this section, remove all four lower jumpers: J12, 13, 14, and 15.
2. Output1 is currently set to be on when all four rails are nominal. Change the POT values on each rail to turn on LED0. The easiest way to do this is to use the OLED display for each channel to check for NOM setting, starting with Channel 1.
3. You will notice the other LEDs change as you go through the previous step. Look at the values for outputs in the GUI and then use the POTs to light LEDs 1, 2, and 3; then 4, 5, and 6.
4. Modify the settings for Output 8 (LED7) to indicate all 4 rails are in OV2 condition.
5. Use **Write NVM** and prove your settings on the board (you should not have to use the OLED this time).

Q6. Why can LED0 and LED1 never be lit at the same time?

Q7. What is the value of Nominal for REG1 (Rail A1)?

Q8. What values are represented by the LED display in Figure 1-7 for Rails 1-4?

***Figure 1-7* • LED Example, LED1 and LED6 ON**

Set up the following outputs according to Table 1-1. You are using only Rail A1, so make sure that all the others show Not Relevant or this will not work correctly.

***Table 1-1* • Set Up Outputs**

Output	Value
Output 1	OFF
Output 2	UV2
Output 3	UV1
Output 4	NOM
Output 5	OV1
Output 6	OV2
Output 7	Not OFF
Output 8	No change needed

Q9. Looking at the values in the GUI, what value or status would allow three LEDs to be on at one time?

Test your theory or find the answer using the hardware and the OLED to confirm.

Trimming

First review some of the trimming information and hardware connections. In the SmartFusion A2F200 device, there are only two sigma-delta DACs which can be used for trimming. To trim additional channels on the demo board, you can use PWMs implemented in fabric. In order to use trimming correctly, you must combine the software settings in the GUI with the jumper settings on the board. REG1 and 2 use PWM trimming; REG3 and 4 use SDD Trimming.

There are two types of trimming available; open loop trimming and closed loop trimming. For closed loop trimming to work. you must have the lower jumpers in place to do the feedback or trim connection.

Trimming Demo

1. Start by going back to the default values: **File** > **1 SF_MPM_Reference_Design.txt**.
2. **Write NVM** to program the settings to the board, and press **Reset** when complete.
3. JP12 - 15 should all be in place (Figure 1-8).
4. Set JP17 and 18 left; JP19 and 20 should be set right.
5. Set all POTs to the far left, to ensure a successful power-up sequence.

***Table 1-2* • Rail Settings**

Summary	Rail A1	Rail A2	Rail A3	Rail A4
Software	PWM0 trimming	PWM1 trimming	SDD trimming	SDD trimming
Software	Closed loop	Closed loop	Closed loop	Closed loop
Hardware	JP19 right	JP20 right	JP17 left (SDD)	JP18 left (SDD)
Hardware	JP12 on	JP13 on	JP15 on	JP14 on

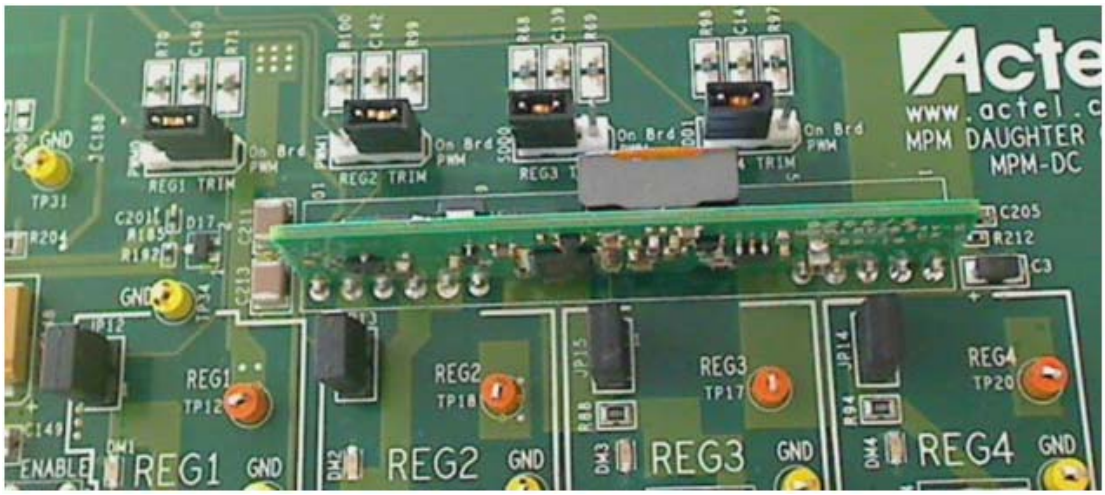

***Figure 1-8* • Jumpers**

1. Set the OLED to view channel 1.
2. Change the POT for REG1. If you turn the POT slowly, the value will be maintained at nominal. If you turn it fast (for example, REG2) it will flick out of nominal momentarily but will be brought back within range.
3. Try the same with REG2, 3 and 4

Q10. Which Regulator has the hardest time staying at Nominal? Can you suggest a reason why?

Answer Sheet

1. What do you have to do to get all four LEDs on and complete the sequence?

2. If Rail A2 fails to reach nominal, what happens to Rail A3?

3. What happens to Rail A4 and why?

4. What would you have to do to get the position on the far left of the OLED to activate?

5. What would you have to do to get OV1 to display?

6. Why can LED 0 and LED1 never be lit at the same time?

7. What is the value of Nominal for REG1 (Rail A1)?

8. What values are represented by the LED display (LED1 and LED6 on) for Rails 1-4 (Figure 1-9)?

***Figure 1-9* • LED1 and LED 6 for Rails 1-4**

9. Looking at the values in the GUI, what value or status would allow three LEDs to be on at one time?

10. Which Regulator has the hardest time staying at Nominal? Can you suggest a reason why?

11. Does Microsemi have plans to obsolete any Microsemi SoC Products Group (formerly Actel) FPGAs?

2 – Advanced Design Challenge

Your system has the following requirement to control four voltage rails:

1. Over volt and under volt flags will remain the same as in the demo example.
2. Rail A1 is untrimmed, remove Jumper JP12.

Timings used must be set so the stages are visually apparent, the graph may not show timing delays clearly, run on hardware to check.

Power-Up

- Rail A2 must start after Rail A3, but only if Rail A4 reaches nominal.
- Rail A1 must start after Rail A3, but only if Rail A2 reaches nominal.

Power-Down

- Rail A4 must power down last.
- Rail A2 must start power down after Rail A3.

Outputs

***Table 2-1* • Outputs**

LED	Condition to Light
LED0	When all Rails are Nominal
LED1	If Rail 4, 3 and 2 are Nominal
LED2	If one rail is in OV2 status
LED3	If one rail is in OV1 status
LED4	If one rail is in UV1 status
LED5	If one rail is in UV2 status
LED6	If any Supply is Off
LED7	When all Supplies are Off

Test Conditions (to be shown on screen only)

Hint 1: The power-up sequence should NOT be the exact reverse of the power-down sequence.

Hint 2: If Rail A3 fails to reach nominal, how many LEDs are on? (The answer is 3.)

A – Answers

Q1. What do you have to do to get all 4 LEDs on and complete the sequence?

Rotate REG3 and REG4 pots counterclockwise.

Q2. If Rail A2 fails to reach nominal what happens to Rail A3?

Turns on simultaneously with Rail A2, but sequence restarts.

Q3. What Happens to Rail A4 and why?

Rail A4 does not turn on due to the failure of Rail A2.

Q4. What would you have to do to get the Position on the far left of the OLED to activate?

Far left value is OFF would need to initiate a power down, Press SW1.

Q5. What would you have to do to get OV1 to display?

Remove JP13 and rotate the REG2 pot clockwise.

Q6. Why can LED 0 and LED1 never be lit at the same time?

Because Output0 indicates Rail A1 is NOM and Output1 indicates that Rail A1 is at UV1.

Q7. What is the value of Nominal for Reg 1 (Rail A1)?

The nominal value is a range from 3100 mV to 3400 mV.

Q8. What values are represented by the LED display shown in Figure A-1 (LED1 and LED6 on) for Rails 1-4?

Figure A-1 **• Display with LED1 and LED6 ON**

Rail A1 at UV1 (3100 mV); Rail A2 at OV1 (1550 mV).

Q9. Looking at the values in the GUI, what value or status would allow 3 LEDs to be on at one time?

Rail A1 at UV2 or OV2.

Q10. Which Regulator has the hardest time staying at Nominal can you suggest a reason why?

Rail A3 – The rnage of the POT is wider than the Trim pin capability of the regulator ?

Q11. Does Microsemi have plans to obsolete any Actel FPGAs?

No. None, never!

B – Product Support

Microsemi backs its products with various support services including Customer Service, a Customer Technical Support Center, a web site, an FTP site, electronic mail, and worldwide sales offices. This appendix contains information about contacting Microsemi SoC Products Group (formerly Actel) and using these support services.

Customer Service

Contact Customer Service for non-technical product support, such as product pricing, product upgrades, update information, order status, and authorization.

From Northeast and North Central U.S.A., call **650.318.4480**
From Southeast and Southwest U.S.A., call **650. 318.4480**
From South Central U.S.A., call **650.318.4434**
From Northwest U.S.A., call **650.318.4434**
From Canada, call **650.318.4480**
From Europe, call **650.318.4252** or **+44 (0) 1276 401 500**
From Japan, call **650.318.4743**
From the rest of the world, call **650.318.4743**
Fax, from anywhere in the world **650.318.8044**

Customer Technical Support Center

Microsemi staffs its Customer Technical Support Center with highly skilled engineers who can help answer your hardware, software, and design questions. The Customer Technical Support Center spends a great deal of time creating application notes and answers to FAQs. So, before you contact us, please visit our online resources. It is very likely we have already answered your questions.

Technical Support

Visit the Customer Support website (www.actel.com/support/search/default.aspx) for more information and support. Many answers available on the searchable web resource include diagrams, illustrations, and links to other resources on the website.

Website

You can browse a variety of technical and non-technical information on the SoC home page, at www.actel.com.

Contacting the Customer Technical Support Center

Highly skilled engineers staff the Technical Support Center from 7:00 a.m. to 6:00 p.m., Pacific Time, Monday through Friday. Several ways of contacting the Center follow:

Email

You can communicate your technical questions to our email address and receive answers back by email, fax, or phone. Also, if you have design problems, you can email your design files to receive assistance. We constantly monitor the email account throughout the day. When sending your request to us, please be sure to include your full name, company name, and your contact information for efficient processing of your request.

The technical support email address is soc_tech@microsemi.com.

Phone

Our Technical Support Center answers all calls. The center retrieves information, such as your name, company name, phone number and your question, and then issues a case number. The Center then forwards the information to a queue where the first available application engineer receives the data and returns your call. The phone hours are from 7:00 a.m. to 6:00 p.m., Pacific Time, Monday through Friday. The Technical Support numbers are:

650.318.4460
800.262.1060

Customers needing assistance outside the US time zones can either contact technical support via email (soc_tech@microsemi.com) or contact a local sales office. Sales office listings can be found on the website at www.actel.com/company/contact/default.aspx.

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